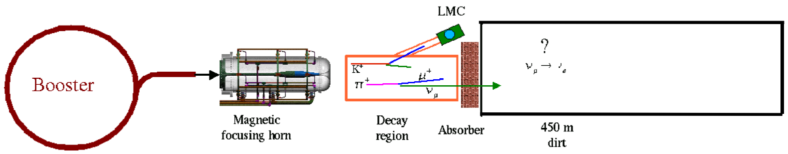
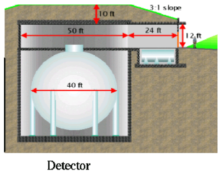
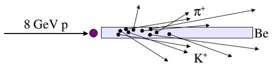






$\pi^+ \to \mu^+ + \nu_\mu$ — source of ν_μ

$\hookrightarrow e^+ + \overline{\nu}_\mu + \nu_e$ — source of ν_e background

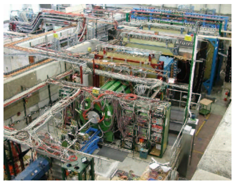
$K^+ \to \mu^+ + \nu_\mu$ — source of ν_μ

$K^+ \to \pi^0 + e^+ + \nu_e$ — source of ν_e background

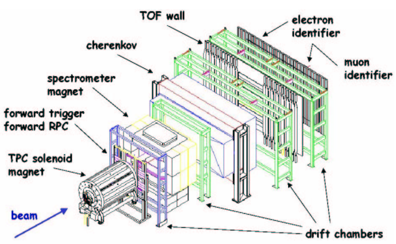
$K^0_L \to \pi^- + e^+ + \nu_e$ — source of ν_e background

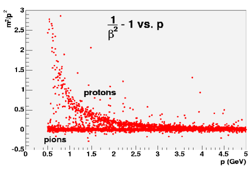
Understanding the Neutrino Flux with help from the HARP Experiment

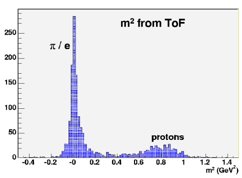
MiniBooNE has teamed up with the HARP experiment (PS214) at CERN to study secondary meson production cross sections at 8 GeV proton beam energy. Over 20 million triggers were recorded by the HARP spectrometer using a MiniBooNE replica beryllium target in summer 2002. The analysis of these data is currently in progress.



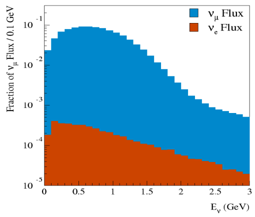
Particle ID is achieved with a Time Projection Chamber, a threshold Cerenkov detector, time-of-flight system and a muon and electron veto system. Momentum reconstruction is done with a dipole magnet/drift chamber spectrometer system.





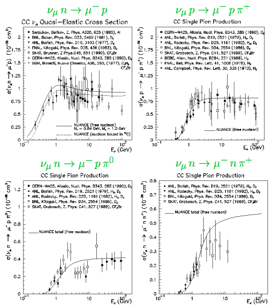


The HARP spectrometer continues to be calibrated and the reconstruction improved. Currently, however, PID by time-of-flight is active as shown in the above figures. On the left we see that pions become separable from protons below ~2.5 GeV/c. On the right is a m^2 distribution for particles with momentum below 2.5 GeV/c as calculated by the ToF system.

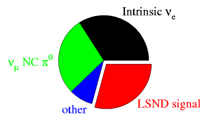


The expected flux of muon neutrinos and intrinsic electron neutrinos without oscillations is very important. The above figure shows the current estimates as a function of neutrino energy. There are many efforts underway to improve our understanding of these fluxes.

The next critical step, of course, to understanding the event rate is to correctly model the neutrino interaction cross-sections in the detector. The plots below show comparisons between cross-section data and the NUANCE-based MiniBooNE Monte Carlo.



After nearly three years of running and collecting $1 \mathrm{x} 10^{21}$ protons on target, the data will be analyzed for a $\nu_\mu \to \nu_e$ oscillation signal over the intrinsic and mis-ID backgrounds. The pie chart below shows the relative contributions to the data for a signal matching that of LSND.



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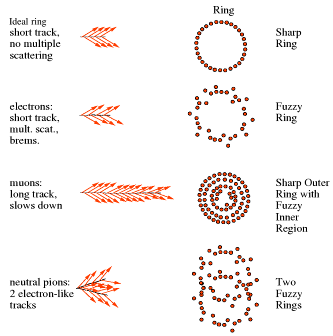
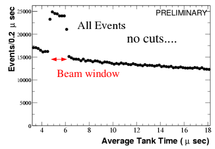
Cerenkov Light in the Detector.....

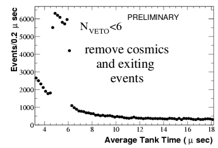


Identifying Neutrino Events in the Detector

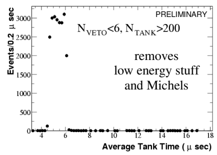
Electrons and muons have distinct signatures in the detector (see images above). The observed rates of electron and muon neutrinos, when compared to the expected flux, will tell us if the neutrinos are oscillating between flavors.

The proton beam has a very clean timing structure that allows a very efficient cut of background events with very simple cuts.



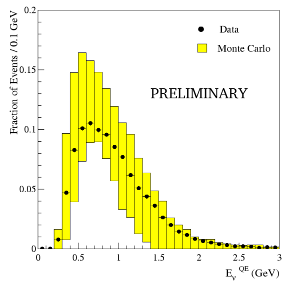


lots of neutrino candidates with a few simple cuts



A more sophisticated set of cuts based on a Fisher discriminant method is then used to isolate the charged current quasi elastic events $(\nu_\mu + n \to \mu^- + p)$ in the detector.

The figure on the right compares this sample to the neutrino energy spectrum predicted by the Monte Carlo. The yellow bands represent conservative estimates of all systematic uncertainties from fluxes, cross-sections, optical properties of the oil in the detector and more.



The neutrino energy can be reconstructed based on the muon energy and the direction observed in the final state.